Elastic Service Model for Smart Learning based on Cloud Environment

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***Abstract*— One of the interesting and realistic application areas for context-aware and cloud computing technologies are the learning systems. In order to add those technologies to the e-learning services that already exist, there is a need for a service architecture model that transforms the already existing situation-aware e-learning environment to an environment that understands context also. We propose using elastic computing in cloud computing for a new notion in smart learning. Our suggestion is the elastic conductor which including the four smarts concept to the cloud services in order to make smart learning services possible. The benefits of smart computing for e-learning solution, which use the handle intelligently to meet the users' needs, are the focus of this paper. This is achieved by going through the collecting user's behavior, prospecting, building, delivering and rendering steps. The smart-learning model that is proposed in this paper will show that it is possible to make customized and personalized learning services in different fields.**

Keywords-elastic computing, e-learning, context-awareness, synchronization, fusion content, cloud environment

I. INTRODUCTION

The smart learning (s-learning) has become an important way of learning during the last few years. It has been made possible by the recent advancements in the Mobile Internet and Information technologies. The S-learning has a major role in creating a good and personalized learning environment, and also being well adapted to the current education model wherever possible [1][2][3]. Usually, the teaching and learning that e-learning offers is only inside of a lecture-style classroom with desktop computers. Though the students could download information and browse through the existing e-learning platform regardless of time and place, they were still confined to the limits of the wired classroom-setups.

The concept of s-learning plays an important role in the creation of an efficient learning environment that offers personalized contents and easy adaptation to current education model. It also provides learners with a convenient communication environment and rich resources. However, the existing-learning infrastructure is still not complete. For example, it does not allocate necessary computing resources for s-learning system dynamically [4][5]. Currently, the majority of s-learning systems have difficulty in interfacing and sharing data with other systems, i.e., it falls short of systematic arrangement, digestion and absorption of the learning contents in other systems. This may lead to duplication in creating teaching resources and low utilization of existing resources. To resolve this problem, it is recommended to use cloud computing to support resource management.

The cloud computing environment provides the necessary foundation for the integration of platform and technology. It integrates teaching and research resources distributed over various locations by utilizing existing conditions as much as possible to meet the demands of the teaching and research activities. The cloud computing environment with respect to s-learning offers new ideas and solutions in achieving interoperability among heterogeneous resources and systems. The cloud services mean that the Internet can be used as huge workspace, repository, platform, and infrastructure.

Learners can access to the Internet from anywhere at any time, using widely spread mobile devices but the existing cloud computing technologies are only passively responsive to users' needs. This situation necessitates proactive cloud services rather than passive services. Since learners typically carry mobile devices of some kind at their hands, the volume of information and services processed through the devices continues to increase.

In this paper, we propose a elastic learning conductor for smart learning contents through the four smarts concept based on the user behavior acquired by the sensors in the user' mobile device. The elastic conductor is making a collection all information of user. The information of user is included the information about the user action, device and total user's environment received by sensing data. Sensing data coming from various sensors mounted on a smart phone, because the users always is have smart phone in their general life time. This application is running data within the smart phone and it is good information for the appropriate situation awareness. In addition, the web browsing is access information identify the main tasks of the users, preference and MAC-address connections are useful in identifying the location. At this point, the correct recognition of the obtained user's situation it is very important.

II. RELATED WORK

Advances in mobile and wireless technologies have changed the way learners' access and share resources, acquire knowledge, and collaborate with each other. Such technologies may include various mobile devices such as

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hand-held computers and smart phones, embedded sensors in those devices, high-speed wireless networking technologies such as 4G networks that allow those heterogeneous devices to interconnect together. The platform advancements enable context awareness in a smart cloud computing environment and smart services for innovative learning processes. The rest of this section discusses a cloud computing project that uses cloud-based applications in s-learning and an overview of context-awareness in a learning environment.

The cloud computing is defined as a technology that provides its users with IT resources by using the Internet as a medium. The users can use IT resources such as application software or storage space from the cloud without needing to own them. The users only need to pay per usage charges for the resources they used. The concept of cloud computing is not new. It is the combination of distributed computing, grid computing, utility computing, *etc.* [6][7][8].

There are a number of cloud-based applications available in the e-learning sector as well. Casquero *et al*. [9] presented a framework based on iGoogle and using the Google Apps infrastructure for the development of a network of cooperative personal learning environments. They discussed the integration of institutional and external services in order to provide customized support to faculty members in their daily activities. They also take advantage of the framework as a test-bed for the research, implementation and testing of their educational purpose services. Marenzi *et al.* [10] investigated how educational software can be used in an academic or corporate learning environment. They integrated models and tools that they developed into an open source environment for the creation, storage and exchange of learning objects as well as learning experiences. They presented the "LearnWeb 2.0" infrastructure to support lifelong learning and to enhance the learning experience. This infrastructure brings together information stored on institutional servers, centralized repositories, learners' desktops, and online community—sharing systems like Flickr and YouTube. Sedayao [11] proposed an online virtual computing lab that offers virtual computers equipped with numerous applications such as Matlab, Maple, SAS, and many others that can be remotely accessed from the Internet.

III. ELASTIC LEARNING SYSTEM

The cloud computing enable cloud servers to provide smart learning service to users through additional intelligent processes on existing cloud system. The most important responsibility of the servers is to perform elastic processes such as Elastic Computing for Infrastructure as a Service (IaaS), Elastic Management for Platform as a Service (PaaS) and Elastic Deployment for Software as a Service SaaS) constantly. The elastic processing can be described as collecting user information that is pulled by the sensors in the users' mobile devices and process the pulled information in real-time so that it can accommodate users' changing situation dynamically[12].

To satisfy the requirements of IaaS, such as storage limitation and processing power, the server must be equipped with virtualization capabilities for mass storage and infrastructure in the cloud by incorporating elastic computing, which means that the elastic computing supports dynamic adaptation for the needs of the computing environment. This can be accomplished by a decision policy that can handle users' changing situations.

In this paper the Elastic Conductor performs provisioning and scheduling for the decision of smart activities. The provisioning and scheduling are performed through an inference engine that utilizes the rules based on three attributes—an object id for user context, a predicate relationship for user behavior, and a value for thinking. The elastic conductor is utilized in PaaS as a smart activity.

The Elastic Conductor it can also generate user interface configurations, such as personalized views and content rendering for each individual user. These processing tasks include four smarts concept: Behavior sensing, Behavior matching, Synchronization and Push – for displays multi-contents on the multi-device or all content on the one device to render learning content. Using sensing context-awareness through the location and IP address of each device, it can orchestrate all devices. Therefore, the multi learning contents can be played in different devices separately to form a "virtual class". The architecture of the model is show in the "Fig.1".

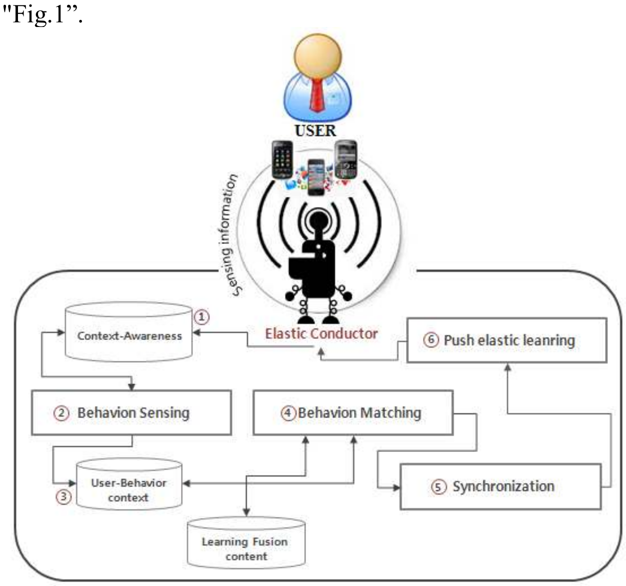


Figure 1. Elastic conductor architecture

The "Fig. 1" shows how the conductor provides smart learning to the user. The information of the user included the information about the user and the device, received by context-awareness sensor. Context-awareness monitoring monitors user request(s) and the kind of device(s) that the user is currently using. By using the information collected by the sensors, conductor (1) pulls the sensing information and analyses the extractable contents. The behavior sensing (2) concept is functioning as an information filter that extracts only the intended information from sensing data and (3) storage in the user-behavior context DB. There can be multiple contexts in sensing data depends on the services available in the learning management system. The behavior matching (4) is the process of rating learning object - in the learning fusion content DB through a variety of sensors from the user behavior DB - for extract information to obtain a correct set of values of the requested learning. They are individually (5) synchronized and pushed (6) by smart learning service.

The sensing data analysis process identifies different background of each learner and accommodates each learner's needs individually. Learning contents are customized based on the background and learning needs. It means that different learning content may have unique technical and functional characteristics and may use different communication channels. Each customized learning contents may differ in modality (text-based, audio, video, etc.), capability (bandwidth), and timing (types of synchronization). The context-awareness included the context models that consist of the user situation and user environment.

The user situation contains the detail information about users. The user preference in user situation specifies user actions and required services. A user action indicates preference on user's request about learning services. The required service should help users acquire knowledge in the area of interest, share experience, and collaborate each other in learning. Each user's personal information such as personal context is secured by some security setting such as user's schedule and location.

The user environment includes each terminal's GPS, MAC address, capability, software interface status, and types of software applications. Able to provide current location and time (a smart phone equipped with clock and GPS reader, IP address and AP (Access Point). The terminal capability describes the process speed, memory, screen size, resolution, and interface types. The terminal application type describes software applications installed in the terminal. The application type is based on quality of service (QoS) parameters, such as response time, delay, jitters and bandwidth. It can be categorized into four types, namely (i) conversational service, such as VoIP; (ii) real-time (RT) service such as Internet Protocol Television (IPTV) and mobile TV; (iii) non-real-time (NRT) services such as email or ftp; (iv) interactive services such as web browsing. The context model has user situation such as user's request and the device they are using. Using this information, the ELS can provide user-aware smart learning service.

The context model deals with the context objects and the relations among them. Since the context-aware module considers the characteristics of each user individually such as learners' knowledge interests, needs, expertise, and experiences, it can provide highly customized and relevant learning services to each user.

IV. THE ELASTIC CONDUCTOR SYSTEM

A. Behavior Sesing

To provide the smart learning service to each individual user, the behavior sensing concept must automatically deduce the actual situation from the user's situation. The behavior sensing is the process of extracting user's behavior information through a variety of sensors to filter information from the sensing information. The filtered information is analyzed to determine user's behavior patterns which the collaboration context information to receive a correct set of user preference, GPS and value of terminal MAC-ID (show the "Fig. 2")

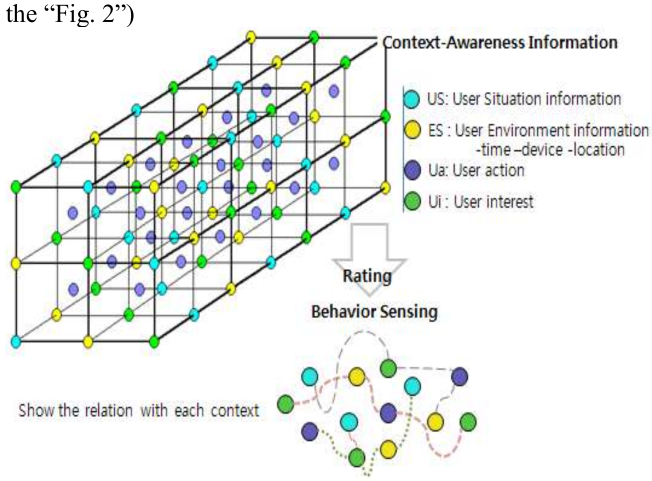


Figure 2. Behavior sensing domain ontology

The filtered process in behavior sensing is defined with the rating function as:

$$R: Ua \times Ui \times T \times L \times D \rightarrow Rating, \qquad (1)$$

where Ua is user action, Ui is user interest, L is location, T is time, D is device are the information of user situation and user environment sensing respectively, *Rating* is the information of rating. The Ua dimension is defined as $User \subseteq U\ action \subseteq U\ request \subseteq Learning\ object | title$ and consist of set of user situation. Similarly, the Ui dimensions are defined as $User \subseteq U\ interest \subseteq U\ needs \subseteq U\ expertise | experience.$ The L is defined as $Location \subseteq Home \subseteq Street \subseteq Company.$ The T is defined as $Time \subseteq Month \subseteq Day \subseteq Morning \subseteq Lunch \subseteq Afternoon \subseteq Evening.$ Finally, the D dimension can be defined as $Device \subseteq Terminal\ MAC\ ID \subseteq Application\ type.$

For instance, continuing $Ua \times Ui \times T \times L \times D$ example considered above, we can define a rating function R on the filtered process $Ua \times Ui \times T \times L \times D$ specifying what a user's request $Ua \in User\ action$ and how much user interested item $Ui \in User\ interest$ at the time $T \in Time$ in user's location $L \in Location$ and used application type of device $D \in Device,\ R(Ua,Ui,T,L,D).$ Visually, ratings R on the filtered process is can be stored in a multidimensional cube, such as the one shown in "Fig. 3".

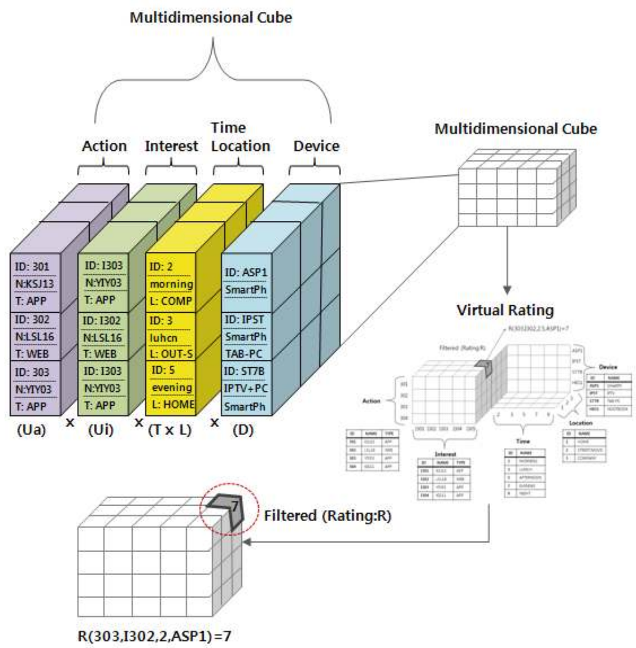


Figure 3. Rating for the $Ua \times Ui \times T \times L \times D$ in filtered process

The double cube in "Fig.3" is stored rating R(Ua, Ui, T, L, D) for the filtered proves Ua × Ui × T × L × D, where the five tables define the sets of user action, interest, location, time and device associated with Action, Interest, Time x Location and Device dimensions respectively.

For example, the rating R(303,I302,2,ASP1)=7 in Fig. 3 is means that for the action with action ID 303, the user's interest learning object is interest ID I302 and using this item mainly Time ID 5 in the Location Company, rating 7was specified during in the device ID ASP1. In other words, the user every afternoon is using application (ID I302) at the street using smart phone. So that filtered data is basis for creating user behaviour database (DB) for providing smart learning service. According to following classification the situation is determine then user behaviour database will be created.

B. Behavior Mapping

The behavior mapping is the process of extracting learning object in fusion learning DB through a variety of sensors from the user behavior DB. The fusion learning DB consists of various multimedia learning materials such as video, text, PPT and image scattered in different learning DB, that model has been developed by Yoon [12]. The Table 2 shows a mapping method for extracting a learning object (ObjectNo) based on a user request action in the user behavior DB. For this, the mapping checks the *R (Ua, Ui, T, L, D)* information to obtain a correct set of values of the requested learning. The set consists of the user's learning request action, learning interests, needs, and the application type currently in use. The behavior mapping causes a matching search of learning object in the Fusion learning DB.

TABLE I. BEHAVIOR MAPPING METHOD

Behavior Mapping
input : User Behavior DB(UB_DB); Learning Fusion DB (FL_DB) output : the ObjectNo$_i$ of learning fusion contents
1. UB_DB={User action, Device(run app)} 2. FL_DB={ObjectNo$_1$,….. ObjectNo$_n$} 3. Matching method if FL_DB{ObjectNo$_n$}== User action true && FL_DB{ObjectNo$_n$}== Device(run app) true 4.return ObjectNo$_i$

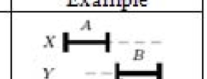
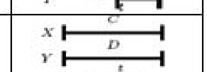
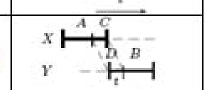
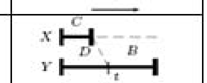
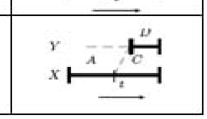
The matching search uses two conditions to find the right ObjectNo in the DB. First, the ObjectNo content is the mapping to user action object. Second, the ObjectNo content type is the mapping to the running application type in the user environment. It may occur when a user uses multiple devices. If an ObjectNo satisfies both conditions, the ObjectNo is sent to the next step for synchronization.

C. Synchronization

The Synchronization module provides three aspects - maintainability, reusability and consistency checking - to conduct the media in the multi-screen. The control rule allows harmonizing service that handles an unordered list of value for the attribute *start* and *end*. All possible predicate for temporal relations in the control rules are based on timeline rules that have been previously established by Allen [8]. The list in the Table 2 contains both rule schema of events and a time instant for media synchronization. For example, when the media is reached at the time instant that defines the start time and end time in the control rule, the media is played at start time and stopped at end time. Also, when the defined event in the control list occurs, then the relation media is played.

Rules STREAM-VALUE-LIST+END in the Table 2 describe the behavior of elements with a list of values, like time and event, for the attributes start.

TABLE II. SYNCHRONIZATION METHOD

Leaning content Relations	Time Schedule	Synchronization Example
UbeforeV	$A \mapsto_I B$	
UequalsV	$(C \Rrightarrow D)$	
UmeetsV	$A \mapsto_I (C \Rrightarrow D) \mapsto_I B$	
UstartsV	$(C \Rrightarrow D) \mapsto_I B$	
UfinishesV	$A \mapsto_I (C \Rrightarrow D)$	

The relation "$\rightarrow$" is the partial order relation on E (event). The relation "$\rightarrow_I$" is accomplished if the following two conditions are satisfied:

1) $A \mapsto_I B$ if $a^+ \mapsto_{E'} b^-$
2) $A \mapsto_I B$ if $\exists\, C \mid (a^+ \mapsto_{E'} c^- \wedge c^+ \mapsto_{E'} b^-)$

Where a^+ and b^- are the end point of A and B, respectively, c^- and c^+ are the end point of C.

In this case, is the subset composed by the endpoint send events ($\rightarrow_{E'}$) of the intervals in I. Finally, the intervals between A and B are said to be simultaneous "$\equiv\succ$" if the following condition is satisfied:

1) $A \Rrightarrow B \Rightarrow a^- \parallel b^- \wedge a^+ \parallel b^+$

The definition above means that one interval A can take place at the "same time" as another interval B.

This streaming control can be used for real-time cooperative systems since the precedence dependencies among the media involved can be established at an execution time according to the behavior of the system.

D. *Push learning service*

The last step of elastic conductor is the Push process. The Push delivers the learning service for user after the fusion contents are adapted device and content are synchronized. As for the content delivery, the situation analyzer will be used. The situation analysis links the contents and devices so learners can use the learning contents at their device. The situation analyzer uses the user environment information to find the related details of the contents and devices. The related details for the contents are time, memory, resolution and application types for the contents. The related details for device are process speed, memory, screen size, resolution and supported interface types for the terminal. The details of terminal indicate the information about available resources in the current device. If the details of a device and contents are of the same or compatible type, a link can be established and the contents are delivered to the device.

After a device and contents are synchronized by the situation analyzer, the Push delivers the smart learning service to its users. The Push delivers a complete set of smart contents to the user using terminal's MH (Media Hub) and MAC-Address in the context model of physical situation. The media hub recognizes the physical location area of mobile devices that enter to the location range of AP (Access Point). The MH assigns IP-address to mobile device based on MAC-Address. The mobile device is connected to Internet via media hub. So, we can get the physical location information when a mobile device got its IP-address. The MH usually connects to a router (via a wired network), and can relay data between the wireless devices (such as computers or printers) and wired devices on the network. The "Fig. 4" shows the context model of physical situation.

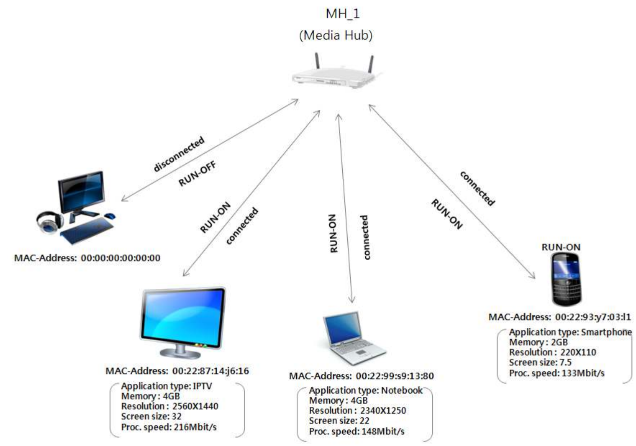


Figure 4. Terminal MAC-ID in the User environment

In the "Fig. 4" is shown the information of the media hub (MH) based on the user's location. According to the user's location, the MH handles with multiple devices that are within the range of the MH. A media hub connected directly to a wired LAN provides a connection point for wireless users. If more than one access point is connected to the LAN, users can roam from one area of a facility to another without losing their connection to the network. As users move out of range of one MH, they automatically connect to the network (associate) through another MH. The roaming process is seamless and transparent to the user.

The MH's generic information describes the status of the network connection, such as connected or disconnected. As shown in the Fig. 4, we can know a position of the user from the location area of MH-1. It is because MHs configures a MAC (Medium Access Control)-Address and IP-address within its location range. To conserve and effectively manage the resource of the devices, the MH performs the MH Controller. The MH Controller manages the MAC-Addresses for transmitting the learning contents to the linked devices according to the context model.

V. CONCLUSION

Modern learning services typically deal with multi-media resources such as graphics, video, images; text *etc.*, since such resources provide an efficient learning environment that helps learners understand the topic of interest better. The awareness of user behavior in the learning process can be very helpful in providing the right contents at the right time. The learning services that include the concept of such awareness and the capability of handling multi-media resources efficiently can be termed smart learning systems. In this paper, we have introduced the use of context-awareness for user behavior and a way to deliver the corresponding contents to the users.

The concept of the context model in context-awareness was introduced, which includes the static and dynamic descriptions of the user action and user environment. The context model deals with the context objects and the relations among them. The results of the context-awareness allow learning efficiency and outcomes for smart learning, such as learners' knowledge interests, needs, expertise, and experiences. Using the context model, the elastic learning conductor can provide the necessary contents to users precisely. In order to collect user's behavior, sensors in users' devices were used. Based on the sensing information, the cloud computing environment can forecast and prepare the contents by analyzing the collected information. Such a process enables smart learning services to provide the contents to the users at an appropriate time.

In order to deliver such customized contents to the users at right time, the smart learning followed four smarts concept - *behavior sensing, behavior mapping, synchronization and push learning service*. All the services are based on the collected data through the sensors in user's device. We have utilized the elastic learning conductor model and analyzed the sensed information within the category of context. The context-aware model handles the fusion media adaptation, synchronization, and transmission for a smart learning service. We have considered various requirements that for the users, the networks, and the cloud. As a future work, the protocols for smart cloud computing and domain specific ontology will be investigated.

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